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ABSTRACT

This study first investigated the importance of ball control and (self-reported) self-regulatory skills in achieving the elite level in basketball. The second aim was to gain insight into the development of, and association between ball control and (self-reported) self-regulatory skills that contribute to achieving the elite level, with taking into account positional differences. Talented male players (N = 73; age 16.56 ± 1.96) completed the STARtest to measure ball control and a questionnaire to measure (self-reported) self-regulation from 2008–2012. Results showed that (self-reported) reflective skills were most important to achieve the elite level (OR = 11.76; P < 0.05). There was no significant improvement in (self-reported) reflection over time for guards, forwards, and centers. Improvement in ball control was evident for guards (r = −0.65; P < 0.05). Furthermore, guards and forwards had better ball control compared to centers (P < 0.01). For those two positions, negative correlations were found between (self-reported) reflection and ball control, i.e., higher reflection was related to better ball control (guards r = −0.19; forwards r = −0.18) in contrast to centers (r = 0.34). It is concluded that (self-reported) reflective skills are important to achieve the elite level, while ball control seems especially important for guards.

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KEYWORDS
Talent development; self-regulation; adolescence; performance; sport

Introduction

Adolescent basketball players aiming to achieve the elite level of performance need to develop outstanding performance characteristics, such as a high level of physiological (e.g., endurance and speed) and technical characteristics (e.g., ball control) (Torres-Unda et al., 2013). Ball control is a particularly important skill for basketball players, since dribbling the ball while changing direction is required to achieve successful performances (Cortis et al., 2011; Fujii, Yamada, & Oda, 2010; Torres-Unda et al., 2013). However, the importance of these skills can vary between different playing positions. Basketball players can be roughly divided into three playing positions (guard, forward, center), which each have slightly different roles to perform. Due to these various requirements, different skills are needed to play well in each playing position (Abdelkrim, Chaouachi, Chamari, Chtara, & Castagna, 2010; Hoare, 2000; Sallet, Perrier, Ferret, Vitelli, & Baverel, 2005). Guards initiate the offense and therefore need to be fast and agile with the ball. Forwards are often the best attacking players in a team, whereas centers need to be very tall and physically strong to score and block opponents' shots. These position-related demands are reflected in, for example, anthropometrical (Abdelkrim et al., 2010), physiological (Abdelkrim et al., 2010), and technical differences between players (Tsitskaris, Theoharopoulos, & Garefis, 2003). Research has shown that guards are the smallest players and the fastest on sprint and dribble tests (i.e., have best ball control). Centers are the tallest players, performing worst on sprint and dribble tests (Abdelkrim et al., 2010; Köklü, Alemdaroğlu, Koçak, Erol, & Findikoğlu, 2011; Ostojic, Mazic, & Dikic, 2006; Sallet et al., 2005; te Wierike, Elferink-Gemser, Tromp, Vaeyens, & Visscher, 2015; Tsitskaris et al., 2003). Talented athletes often spend many hours in training to improve those skills which are especially important in their chosen sport (e.g., ball control in basketball) (Ward, Hodges, Starkes, & Williams, 2007). According to Ericsson, Krampe, and Tesch-Romer (1993), at least 10,000 hours or ten years of deliberate practice are needed to reach expertise. These years of training can be labelled as the sampling (ages 6–13), specializing (ages 13–15) and investment years (ages ≥ 16), in which the amount of training hours in one main sport increases over the years (Côté, 1999; Côte, Baker, & Abernethy, 2007). During these hours of deliberate practice, athletes should remain cognitively engaged in order to improve their performance continuously (Côte et al., 2007; Ericsson, 2003). This statement is in line with Zimmerman's theory of self-regulated learning; athletes who want to improve themselves should be metacognitively (reflection, planning, monitoring, evaluation), motivationally (effort, self-efficacy), and behaviourally active in their own learning (Zimmerman, 1986, 1989, 2006). Models of self-regulated learning incorporate cognition, motivation, and behaviour making them well suited to explain sport training, in which deliberate practice has been given a central role (Baker & Young, 2014;

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Ericsson et al., 1993). Examples of such models are Zimmerman's tri-phasic model with the forethought, performance, and reflection phase (Cleary & Zimmerman, 2001) as well as Winne and Hadwin's (1998) self-regulated learning model which holds four, loosely sequenced phases. This last model distinguishes task perceptions, goal setting and planning, task enactment, and adaptation (optional phase). These models can be used to explain performance improvement. For example, a player wants to improve his ball control since this is an important skill in basketball considering the task requirements of this game. The player needs then to be aware of his own weaknesses and strengths related to his ball control (reflection), and needs to make a plan how to improve this skill (planning). In addition, he should monitor and evaluate the process, should put effort in it and believes that he is able to achieve his goal (self-efficacy) (Ertmer & Newby, 1996; Zimmerman, 1986, 2006). This self-regulated learning can for example be expressed by players by being on time at training, taking initiative during exercises, and asking for feedback from the trainer (Elferink-Gemser et al., 2013; Toering et al., 2011). Research has shown that higher skilled athletes have better self-regulatory skills, especially reflection (Cleary & Zimmerman, 2001; Jonker, Elferink-Gemser, de Roos, & Visscher, 2012; Toering, Elferink-Gemser, Jordet, & Visscher, 2009). Athletes with a high level of reflection are expected to improve themselves on those skills which are important for their position. Consequently, they are hypothesized as more often attaining the elite level of performance compared to players with lower reflection scores (Jonker, Elferink-Gemser, Toering, Lyons, & Visscher, 2010; Toering et al., 2011). This study first investigated the importance of ball control and (self-reported) self-regulatory skills for talented basketball players in order to achieve the elite level of performance in adulthood (>20 years). The second aim was to gain insight into the development of, and association between ball control and the (self-reported) self-regulatory skills that contribute to achieving the elite level (based on the results of aim 1), while considering positional differences.

Methods

Participants

A longitudinal dataset consisting of (self-reported) self-regulatory skills and ball control for 73 adolescent male basketball players was used in this study. To investigate the importance of ball control and (self-reported) self-regulatory skills in order to achieve the elite level of performance (> 20 years in 2014), a subgroup of 29 players was analysed. Eleven basketball players (3 guards, 5 forwards, 3 centers) achieved the elite level of performance (the highest level in the *** basketball competition) (mean age 17.96 ± 0.92 during measurements). Eighteen players (4 guards, 11 forwards, 3 centers) did not achieve the elite level of performance (second level or lower) (mean age 18.16 ± 1.17 during measurements). There were no significant differences in age and amount of training hours between both groups at time of measurement ($F(1,27) = 0.23$; $P = 0.63$; and $F(1,26) = 3.58$; $P = 0.07$, respectively). For the second aim, data of all 73 adolescent male basketball players were analysed to investigate the development of ball control and (self-reported) self-regulatory skills that contribute to achieve the elite level (based on the results of aim 1) (guards: n = 22, age = 16.42 ± 1.89; forwards: n = 38, age = 16.61 ± 2.04; centers n = 13, age = 16.63 ± 1.84; total: age = 16.56 ± 1.96). An overview of the number of measurement events per age group is shown in Table 1. Age groups were defined using the whole year as the mid-point, i.e., 15 years = 14.50 – 15.49 years. All the players were from one of the selection teams (U14, U16, U18, or U20) and competed at the highest level for their age category in ***. They had 6.16 ± 2.23 years experience at a basketball club and trained 14.56 ± 5.12 hours per week. Players and parents/guardians were informed about this study and provided their written consent. This study was approved by the local ethics committee.

Ball control

The STARtest was used to measure the ball control performances of basketball players. The STARtest consists of basketball-specific movements (Figure 1). Players take off with a flying start through point AB, at which point the timer starts. Next, they dribble the ball forwards to points C and D, backwards to point E, make sideward slides to point F, dribble forwards to points C and D, and then follow the same pattern on the other side of the field (i.e., points G, H, and C). Finally, players dribble forwards to point D and point AB, at which point the timer stops. Time was measured using electronic timing gates (Eraton BV, ***). Before the real measurement started, players walked

Table 1. Number of measurements per player for each age category.

	Number of measurements									
Age (years)	1	2	3	4	5	6	7	8	9	Total (guards – forwards – centers)
13	0	6	2	3	1	1	0	0	0	13 (5 – 7 – 1)
14	2	7	3	6	1	3	0	1	3	26 (10 – 11 – 5)
15	1	6	17	4	7	4	0	2	3	44 (11 – 27 – 6)
16	0	12	5	5	7	5	0	2	4	40 (11 – 23 – 6)
17	2	11	1	5	4	4	1	3	8	39 (13 – 15 – 11)
18	1	4	2	1	5	7	2	4	5	31 (15 – 10 – 6)
19	0	8	5	2	7	4	3	3	2	34 (9 – 23 – 2)
20	1	4	1	2	3	2	1	1	2	17 (2 – 11 – 4)
Total measurements	7	58	36	28	35	30	7	16	27	**244** (76 – 127 – 41)
Number of players	7	29	12	7	7	5	1	2	3	**73** (22 – 38 – 13)

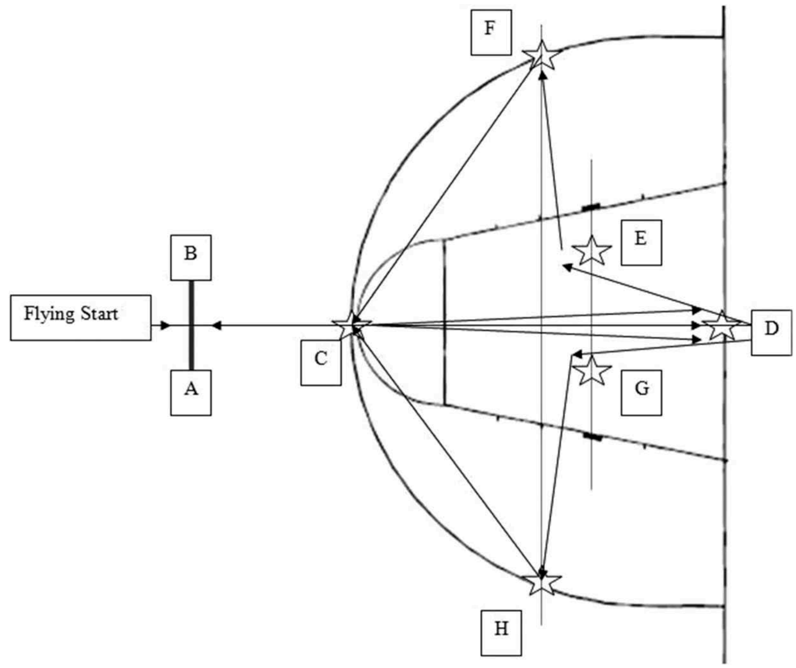

Figure 1. Course of the STARtest.

through the test pattern once, to make sure it was clear to them. During the test, the players were supervised by leaders to prevent them from making mistakes. The reproducibility (reliability and agreement) and validity of the STARtest have been confirmed (te Wierike et al., 2015).

(Self-reported) self-regulation of learning

The (self-reported) self-regulatory skills of the basketball players were measured using the self-regulation of learning self-report scale (SRL-SRS) (Toering, Elferink-Gemser, Jonker, van Heuvelen, & Visscher, 2012). This self-reported questionnaire consists of 46 questions regarding the self-regulatory skills reflection (5 items, 1–5), evaluation (8 items, 1–5), planning (8 items, 1–4), self-monitoring (6 items, 1–4), effort (9 items, 14), and self-efficacy (10 items, 1–4). The reliability and validity of the SRL-SRS was confirmed by Toering and colleagues (2012).

Procedure

All data were collected during the basketball players' adolescence from 2008 to 2012, with multiple measurements each season. Level of performance of players aged > 20 was established in 2014. The players' ball control was measured multiple times each season, while (self-reported) self-regulatory skills were measured once per season. All the tests were carried out in the afternoon, during regular training hours at an indoor sports hall. Players started with a ten-minute warm-up and were then randomly divided into two groups: one group started with the STARtest, while the other group started completing the SRL-SRS.

Data analysis

A binary logistic regression analysis was performed with IBM SPSS Statistics software (version 20.0; Inc., Chicago, Illinois, United States of America) to investigate the importance of ball control and (self-reported) self-regulatory skills in achieving the elite level of performance in adulthood. The (self-reported) self-regulatory skills were, based on theory, divided in a low (for reflection and evaluation 1–4; for planning, self-monitoring, effort and self-efficacy 1–3) and a high group (for reflection and evaluation 4–5, for planning, self-monitoring, effort and self-efficacy 3–4) (Jonker, Elferink-Gemser, & Visscher, 2010). For ball control linearity was checked and not confirmed. Therefore, ball control was divided into five groups with an interval of 0.60 seconds per group (i.e., players with a score of 17.80 – 18.40 seconds on the STARtest with ball were taken together in group 1, players with 18.41 – 19.00 seconds in group 2 and so on). The level of performance in adulthood and all the (self-reported) self-regulatory skills were added as dependent and independent variables, respectively. The Enter method was used to examine the relative contributions of all skills for attaining the elite level. For the second aim, multilevel modelling was used to analyse the longitudinal data. Multilevel models can handle data which are not independent, as is common in a longitudinal design where measurements are nested within players. This advanced statistical method permits variation between the time and number of measurements between players (Landau & Everitt, 2004). In longitudinal designs, players often miss one or more measurements due to, for example injuries, illness or drop-out. Using the MLwiN 2.27 software package, two empty models were created (i.e., for reflection and ball control) as starting points to investigate the development of both skills. In the multilevel models level 1 scores represent the measurements within individual players and level 2 scores represent the differences between individual players. Random intercepts were considered, allowing a unique intercept for each individual player. In addition, random slopes were entered into the models to properly account for correlations among repeated measurements within individuals. Possible predictors for the multilevel models were age and position, which were added to investigate their influence on the development of reflection and ball control. The predicted variables were entered separately into the initial model; during each step goodness of fit was evaluated by comparing the −2*Log likelihood (IGLS deviance) of the previous model, with the most recent model. Variables which were not statistically significant ($P > 0.05$) were removed from further analysis (Rasbash, Steele, Browne, & Goldstein, 2009). We prepared graphs based on the multilevel models created to illustrate the development of (self-reported) reflection and ball control for all three playing positions. Pearson correlations were calculated for each position between age, (self-reported) reflection, and ball control to investigate the rate of development of both skills and their association. The measurement taken closest to the age of 16 was included for each player in this analysis, since this was the mean age of the overall group. A correlation of < 0.10 was interpreted as trivial, r = 0.10 – 0.30 as small, r = 0.30 – 0.50 as moderate, r = 0.50 – 0.70 as large, r = 0.70 – 0.90 as very large, and r > 0.90 as nearly perfect (Hopkins, 2002). Differences between correlations were investigated using Z scores (Weaver & Wuensch, 2013). The statistical significance for all the analyses was set at $P < 0.05$.

Results

Descriptive statistics of ball control and (self-reported) self-regulatory skills of players who did and did not achieve the elite level of performance in adulthood are shown in Table 2.

The binary logistic regression showed that only (self-reported) reflective skills had a significant contribution to achieving the elite level of performance in adulthood (OR = 11.76; 95% CI = 1.34–102.7; $P < 0.05$). The −2*Log likelihood revealed that the model fitted the data when estimation was terminated at iteration number four because parameter estimates changed by less than .001 (IGLS deviance = 31.823). The Nagelkerke R^2 indicated that the model explained 28% of the variance. The development of (self-reported) reflection and ball control for each playing position is shown in Figures 2 and 3, respectively. Age and position were no significant predictors in the multilevel model for reflection ($P > 0.05$). Regarding ball control, improvement over time and differences between positions (guards and forwards faster than centers) were found ($P < 0.05$). There was a moderate but not significant correlation between age and (self-reported) reflection for guards ($r = 0.35$). A trivial and small, also not significant, correlation was found for forwards ($r = -0.03$) and centers ($r = 0.18$). No differences between the three playing positions were found for the rate of development of (self-reported) reflection ($P > 0.05$). Regarding ball control, a large and significant correlation with age was found for guards

Table 2. Descriptive statistics of ball control and (self-reported) self-regulatory skills of players who achieved the elite and non-elite level of performance in adulthood.

	Elite (n = 11)	Non-elite (n = 18)	Total (n = 29)
Ball control (s)	19.62 ± 1.14	19.67 ± 1.02	19.65 ± 1.05
Reflection (1–5)#	4.29 ± 0.29*	4.04 ± 0.31	4.14 ± 0.32
Evaluation (1–5) #	3.65 ± 0.35	3.62 ± 0.45	3.63 ± 0.41
Planning (1–4) #	2.90 ± 0.44	2.72 ± 0.54	2.79 ± 0.50
Self-monitoring (1–4) #	2.90 ± 0.39	2.82 ± 0.48	2.85 ± 0.44
Effort (1–4) #	3.13 ± 0.30	2.94 ± 0.36	3.01 ± 0.34
Self-efficacy (1–4) #	3.20 ± 0.46	3.05 ± 0.41	3.11 ± 0.43

*Players who achieved the elite level of performance scored significantly higher compared to players who did not achieve this elite level ($F(1,27) = 4.62$; $P < 0.05$).
#These variables are all self-reported by filling in the questionnaire (SRL-SRS)

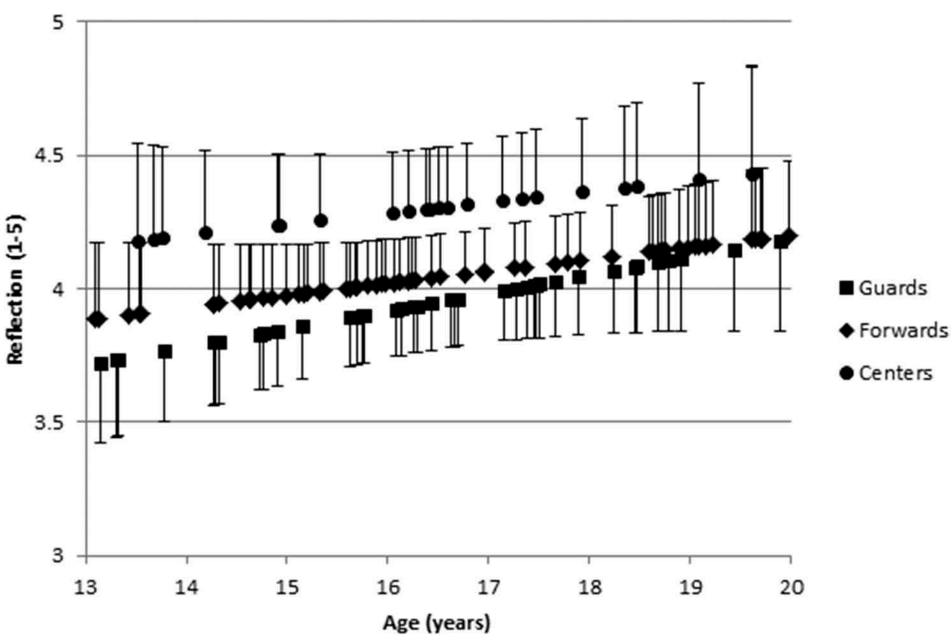

Figure 2. Development of reflection for players of the guard, forward, and center position. Standard deviations are only illustrated in one direction in order to maintain clarity.

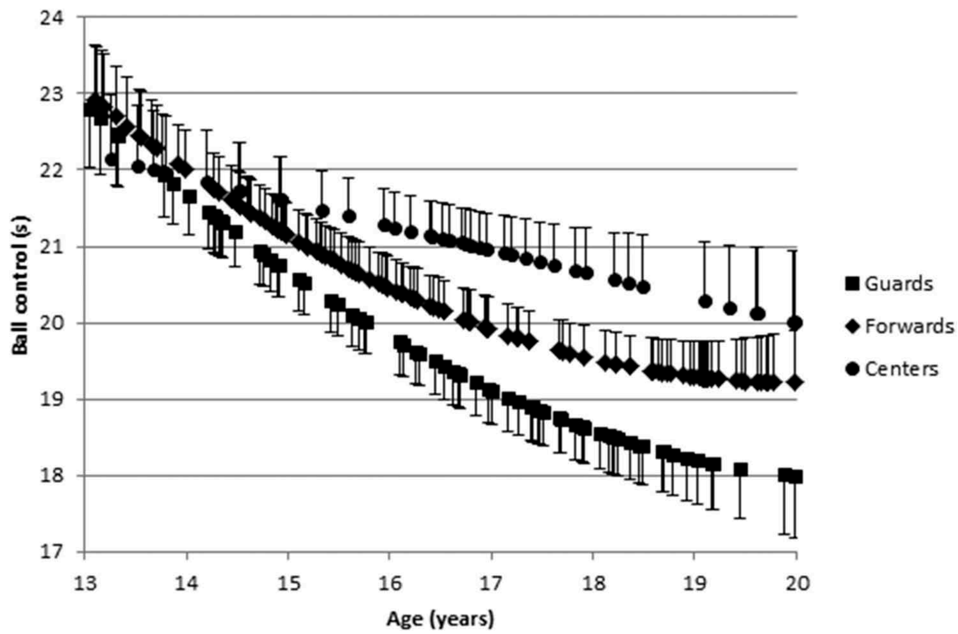

Figure 3. Development of ball control for players of the guard, forward, and center position. Standard deviations are only illustrated in one direction in order to maintain clarity.

($r = -0.65$). In addition, guards showed the highest rate of development over the years (Z = 2.33; $P < 0.05$). A small, non-significant, correlation between age and ball control was found for both forwards and centers ($r = -0.11$ and $r = 0.11$, respectively). Regarding the correlation between (self-reported) reflection and ball control, a small but negative correlation was found for guards ($r = -0.19$) and forwards ($r = -0.18$) (i.e., a higher score on reflection indicates better ball control (less time needed for the test)). In contrast, a moderate but positive correlation between both skills was found for centers ($r = 0.34$).

Discussion

This study examined the importance of ball control and (self-reported) self-regulatory skills in achieving the elite level of performance in basketball. Furthermore, the development of ball control and (self-reported) reflection (as the most important self-regulatory skill), and their association was investigated while considering positional differences. In order to attain the elite level in basketball, players need to develop skills that are meaningful for their position. As shown in literature ball control is an important skill (Torres-Unda et al., 2013), especially for those playing at the guard position. This is also shown in the results of our study. We found that ball control improved with age, especially between ages 13 and 17, which is in line with other research on the dribble performance of talented athletes (Huijgen, Elferink-Gemser, Post, & Visscher, 2009, 2010). Moreover, it was shown that guards and forwards displayed better ball control performance than centers, with the strongest development for guards. In addition, a negative correlation between (self-reported) reflection and ball control was found for guards and forwards, which indicates that players with better (self-reported) reflective skills have better ball control (i.e., they need less time for the STARtest). Guards and forwards could be using their reflective skills to improve ball control, while centers use their reflective skills to improve other skills more important for their position. However, as the correlations were not that strong, and we did not ask the players about their specific use of reflection, we were not able to verify this suggestion. In order to further explore the link between reflection and ball control, it is suggested to observe and interview players before, during, and after training hours. We expect, for example, that the later elite players are more focused on the skill they want to improve compared to later non-elite players, as is also shown in research of Cleary and Zimmerman (2001). The basketball players in their study with a higher level of reflection were more aware of their performances, indicated by more frequent use of specific attributes (e.g., "I did not bend my knees enough") rather than using general attributes to their failures and successes in performing a free throw. This enables them to reflect more specific on their previous performance in order to select technique-specific strategies (e.g., "keep my elbow in") to improve future performance. The scores on all aspects of (self-reported) self-regulation of the basketball players in this study were slightly higher compared to those of other talented athletes (Jonker, Elferink-Gemser, Toering et al., 2010; Jonker, Elferink-Gemser, Visscher, 2010; Toering et al., 2009). From all these (self-reported) self-regulatory skills, it is shown that reflective skills were most important in achieving the elite level of performance in adulthood. Results also implicate that talented athletes already have a high level of reflection from a young age on, which is also shown by other research (Jonker, Elferink-Gemser, Tromp, Baker, & Visscher, 2015). Moreover, our results revealed that from the age of 13, talented basketball players with better (self-reported) reflective skills (i.e., score > 4 on the SRL-SRS (strongly agree with the statements)) are eleven times more likely to achieve the elite level of performance. This is in line with other studies which showed that better performing athletes have better reflective skills, indicating the importance of reflection for talented athletes aiming to achieve high level of performance in sports (Jonker, Elferink-Gemser, Toering et al., 2010, Jonker, Elferink-Gemser, Visscher, 2010; Jonker et al., 2012; Toering et al., 2009). According to the definition of reflection (Peltier, Hay, & Drago, 2006), athletes with good reflective skills are more aware of their performance and are able to improve the skills which are most important for their position, which in turn could lead to a greater likelihood of achieving the elite level of performance. A limitation of this study is the relative small sample size when considering the differences between players in achieving the elite and non-elite level of performance. This is caused by the fact that within a group of talented players, only a few will reach the top in their sport (Malina, 2010). Another methodological issue in this study is the use of a self-reported questionnaire (SRL-SRS). The results of self-reported questionnaires can be biased by social desirability, given the pressures of team selection procedures. Despite these limitations, the results of this study offer further insight into how players of different playing positions achieve the elite level of performance. Furthermore, longitudinal and prospective studies of players as performed in this study are rare. It improves our understanding of the development of adolescent basketball players considered talented into elite or non-elite athletes at age > 20.

Conclusion and practical applications

Acknowledging other important aspects related to basketball talent development, this study provides increased understanding of the development of talented basketball players through adolescence related to technical and psychological skills. Our results showed that having good (self-reported) reflective skills is important for players to achieve the elite level of performance at age > 20. In addition, our results revealed positional differences regarding the development of ball control in talented basketball players. Coaches, trainers and players should be aware of the position-related demands of the guard, forward, and center positions.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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